lic intelligence, as e. g., thru the courses for workingmen; but here also he insisted upon thoroness and genuineness on the part of the teachers. No one thing was more odious in his eyes than that popularization of science which is based upon mere appearance of scholarship.

The severe illness which first attacked him in 1867 was an important factor in determining the decrease of his activities during recent years. With a slow but not uncertain step it brought about the dissolution of the once tireless mind and body which in earlier years had delighted in activity. Early on the morning of July 12, 1877 a gentle and painless death freed this able man from his sufferings, and bore him from the midst of his large circle of friends, admirers, and relatives.

EXPLANATION OF THE TABLE OF EXCESSIVE PRECIPITATION.

The REVIEW publishes each month, in Table IV, a statement of the accumulated precipitation during storms of certain intensities. The actual fall during periods of five minutes, ten minutes, etc., is given, in the right hand columns of this table, for each five minute interval up to 50 minutes, inclusive. When the excessive rate is continuous for more than 50 minutes the accumulated precipitation for such longer periods is printed in the following line or lines, and the actual duration of the given amount is found by adding to the figures printed at the top of the column an additional 50 minutes for each additional line employed. The times of beginning and ending given in columns 5 and 6 of this table will show, in such cases, that the total period is a continuous period and that the depths given are the accumulated depths from the beginning of the excessive rate of fall. In the REVIEW for December, 1905, for example, on page 566, the excessive rate at Atlanta on the 2d was continuous from 6:46 p. m. to 9:13 p. m., and the depth of 1.35 inch given in the 5-minute column is not for 5 minutes, but for 55 minutes, and the depth of 2.20 in the 20-minute column of the line below is for the total period of 120 minutes. The case is similar for Jupiter on the same page. The storm of the 2d at New Orleans, La., is recorded on two horizontal lines, but the times are not continuous, and the amounts given on the second line correspond to the times printed at the top of the columns.

The above explanation is prompted by the fact that some confusion has resulted from a too literal interpretation of the explanatory heading of these right-hand columns.—*F. O. S.*

THE ATMOSPHERE AND THE SOIL.

The Department of Agriculture, thru its various bureaus, seeks to investigate every condition that can in any way affect the growth of the plant and the character, quality, or quantity of the resultant crop. We quote the following paragraphs from an address by Milton Whitney, Chief of the Bureau of Soils, published as Farmers' Bulletin No. 257, on "Soil Fertility". The greater part of the paper is given up to the question of manures and fertilizers, but the following paragraphs relate to atmospheric influences.

Plants must breathe.

Of course we all understand that the breathing of the plant is mainly thru its leaves; but the soil also may be a very important factor in the breathing of plants, as it is necessary to have a supply of oxygen around the roots. Physiologists differ as to the office the roots have in regard to the absorption of oxygen. Whether it is a true breathing—the taking of oxygen for the plant economy thru the roots as thru the leaves—has never been decided; but it is unquestionably a fact that roots of cultivated plants require oxygen around them for their healthy growth. We know perfectly well that cultivation of the soil is important or necessary for the best development of many crops, and we say that this is in order to introduce oxygen and make possible the introduction of more water into the soil.

The investigations of the Bureau of Soils seem to indicate that the actual supply of oxygen to the roots may not be the only or even the most important function of cultivation. It seems necessary not only to introduce air into the soil, but, by stirring the soil, to permit the escape of noxious gases that are perhaps given off by the plants themselves, or produced by bacterial action on the remains or excreta of plants. In a crowded room a person begins to feel drowsy, languid, and his head begins to ache. We speak of these sensations, usually, as due to deficient ventilation, too little oxygen, the oxygen having been partly used up, and to an accumulation of carbonic-acid gas; but physiologists now believe that this is not the true explanation, but that the person suffers because there are gaseous emanations from the lungs that are deleterious to human beings. The plant is exceedingly sensitive to gases. On the streets of Washington one of the principal causes of the death of trees is leaks in gas pipes; every year hundreds and perhaps thousands of trees have to be removed, and the usual cause is a leaking gas pipe. The amount of gas is so small that it can not be detected by the odor, but the influence of the gas on the roots is so pronounced that the tree suffers and is likely to die. It seems probable that the ventilation of the soil is necessary not only to allow air to enter, but to allow gases formed in the soil to escape.

Furthermore, air must enter not only for the use of the root itself, but also to oxidize the organic matters given off by the plants—to preserve the proper sanitary conditions in the soil—as I shall explain later. Ventilation to remove noxious gases might increase the yield without affecting the fertility. Ventilation for the purpose of oxidizing organic matter might affect fertility itself.

THE CLASSIFICATION OF CLIMATES.

We call the attention of our readers to a most instructive series of articles by Prof. R. DeC. Ward, on "The classification of climates", published in the Bulletin of the American Geographical Society, for July and August, 1906. After explaining in detail the many classifications that have been suggested by various students, Professor Ward concludes as follows:

The broad classification of climates into the three general groups of marine, continental, and mountain, with the subordinate divisions of desert, littoral, and monsoon, is convenient for purposes of summarizing the interaction of the climatic elements under the controls of land, water, and altitude. But in any detailed study some scheme of classification is needed in which similar climates in different parts of the world are grouped together, and in which their geographic distribution receives particular consideration. It is obvious from the preceding paragraphs that an almost infinite number of classifications might be proposed; for we may take as the basis of subdivision either the special conditions of one climatic element, as, for example, the same mean annual temperature, or mean annual range of temperature, or the same rainfall, or rainy seasons, or humidity, and so on; or, again, similar conditions of the combination of two or more elements of climate may be made the basis of classification; or we may take a botanical or a zoological basis. Of the classifications which have been proposed, special reference is here made to those of Supan, Köppen, and Hult. That of Supan, taken as a whole, gives a rational, simple, and satisfactory scheme of grouping, whose frequent use in climatic descriptions would tend toward system, simplicity, and facility of comparison. It emphasizes the essentials of each climate, and serves to impress these essentials upon the mind by means of the compact, well-considered verbal summary which is given in the case of each province described. Obviously, no classification of climates which is at all complete can approach the simplicity of the ordinary classification of the zones.

Köppen's admirable scheme of subdividing climates from the botanical point of view is distinctly rather for the use of students of plant geography than of general climatology. The present limits of the different climates in Köppen's map will doubtless need to be changed in several cases, as more detailed botanical studies throw further light on the geographical distribution of different plants, and no rigid delimitation of plant zones is ever satisfactory to everyone. But Köppen's classification has the great merit of recognizing the existing differences of climate between east and west coasts, and between coasts and interiors. The coordination of districts of vegetation and of climate, which this scheme so strikingly emphasizes, is a noteworthy fact in climatology.

Hult's classification is far too detailed, if all the smaller provinces are taken into account; but if only the larger kingdoms are considered, as in Plate II [not reproduced], the scheme is useful. It, however, possesses no advantages over that of Supan, which takes account of more typical characteristics of climate. Ravenstein's hygrothermal types rest upon unsatisfactory data, and regions of very different climatic conditions are grouped together because they happen to have the same mean annual temperature and relative humidity.

THE WEST INDIAN HURRICANES OF SEPTEMBER, 1906.

By E. B. GARRIOTT, Professor of Meteorology.

Tropical storm development was exceptionally active in American waters during September, 1906. In seeking the causes of this activity we find an apparent contributory condition in the distribution of atmospheric pressure over the region of observation. In the West Indies and adjacent waters barometric pressure was unusually low, while in the more northern latitudes of the Atlantic, and more especially from the Azores over the British Isles, the barometer averaged above normal, and after the 17th was remarkably high. This arrangement of air pressure overlying the Atlantic naturally produced an unusually strong flow of air from the more northern latitudes toward the Tropics, and in this accelerated movement of air currents is found a recognized associated cause of tropical storm development. In fact a distortion or reversal of the usual order of barometric distribution invariably produces weather of abnormal types over considerable areas. A notable instance of this kind was presented during the winter of 1904–5 when general and excessive rains occurred thruout New Mexico, Arizona, and southern California. As stated by the Chief of the Weather Bureau at the time[1] the cause of the heavy rains in the southwest was not local, but was associated with general abnormal atmospheric conditions over the United States that were in turn associated with abnormal conditions that obtained over a large part of the Northern Hemisphere. He stated that the association between low barometric pressure and excessive rains in the southwest and high barometric pressure and unusual cold in the north and east had been established, and that during winters of excessive cold in northern and eastern districts of the United States the winters had been unusually wet from western Texas to southern California. During September, 1906, the stormy weather in the West Indian region attended a distribution of barometric pressure over the Atlantic Ocean similar to that observed over the North American Continent during the winter storm period of 1904–5 in the southwestern portion of the United States. Numerous examples of this observed association of apparent barometric causes with weather effects can be cited. Those referred to, however, will answer the present purpose of inviting attention to an arrangement of atmospheric pressure that figures prominently during certain phases of abnormal American weather.

Chart IX shows the paths of the three hurricanes of September, 1906, here discust, over the West Indies and adjacent waters.

THE WEST INDIAN STORM OF AUGUST 31–SEPTEMBER 15, 1906.

The approximate path of the center of this storm has been traced from a position east of Barbados, W. I., on August 31, to the region north of the British Isles, on September 15. Seven days were occupied by the storm in advancing from the ocean east of Barbados northwestward to the northern Bahamas, and two days, the 6th and 7th, in making a recurve over the Bahamas. Moving thence northeastward the center past west and north of Bermuda by the morning of the 9th and reached the region of the Banks of Newfoundland by the 10th. The subsequent path of the storm was north of the region from which observations have been received. As the barometer over the British Isles began to fall on the 11th and continued to fall rapidly until the 15th, when the center of a well-marked and energetic depression past north of Scotland on an easterly course, it may be assumed that this disturbance was identical with the one that moved north of east from the Banks of Newfoundland during the 11th.

During September 1 and 2 the vortex of the storm pursued a course over the ocean east of and near the Lesser Antilles, and by the morning of the 3d had past north of Porto Rico. No reports have been received from vessels that encountered the storm on these dates. The following, from islands of the Leeward group, indicate measures of protection that were taken on advices telegraphed from Washington.

[1] Monthly Weather Review for April, 1905, Vol. XXXIII, p. 152.

Mr. D. Hope Ross, official in charge of the Weather Bureau office at Basseterre, St. Kitts, W. I., reports:

> The morning of the 1st the barometer, which had been steadily falling since 9:30 the previous night, read 29.76 at 6 a. m. It rose slightly, to 29.77 at time of observation, and then fell steadily until 5 p. m. to 29.64, the lowest point reached, after which it rose slowly. The wind steadily decreased from midnight of August 31, and at 12:30 p. m. of September 1 the velocity was less than 3 miles an hour. Shortly after it increased slowly, shifted from north-northeast and north to southwest and south-southwest. It blew steadily from that quarter with increasing force, and reached a maximum velocity of 60 miles at 3:35 to 3:40 a. m., of the 2d, with an extreme velocity for one minute of 70 miles per hour at 3:36 a. m. Rainfalls were heavy, and varied from about 6 to 13 inches at different points on the island. The telegram of advice received the morning of the 1st was issued as a precautionary warning. This was done especially by telephone, to Government offices and other centers in town, and to outlying districts, and all possible information was given to callers at the office. Comparatively little damage was done by the storm. Owing to the prostration of telephone lines communication to outlying points on the island was temporarily cut off; many trees were uprooted, and a few small houses were blown down; but everyone being prepared there appears to have been no further damage.

The following letter, dated September 4, from Mr. Christopher H. Payne, American Consul at St. Thomas, W. I., indicates the character of the disturbance during its passage over the region of the Virgin Islands:

> Your cablegram of September 1, 1906, received, for which I beg of you to accept my sincere thanks; also the business people of this place, as your timely warning has saved millions to shipping in this harbor. I sincerely hope that you will find it a pleasure in advising me of all future disturbances during this dreaded season. I beg to assure you this office is at your command at all times in whatever way we can serve you in your great work.

The Weather Bureau observer at San Juan, P. R., reports:

> The storm apparently followed the course forecast in the message received September 1. All vessels were advised to remain in port; the advices were heeded and no material damage has been reported. Vieques is the reporting station nearest to the path of the storm; no material damage was caused on that island altho 8.48 inches of rain fell on the 4th. The maximum wind velocity at San Juan was 35 miles an hour from the west on the 3d.

During the 4th and 5th the center of disturbance moved northwestward toward the northern Bahamas, passing north of Turks Island on the 4th. During the 6th and 7th it gradually recurved east of the northern Bahamas and was severely felt by vessels navigating that region. At 3 a. m., September 7, the three-masted schooner *John Rose*, John Douglas, master, in latitude north 28° 37′, longitude west 77° 4′, had a barometer reading of 29.01. This vessel was coal-laden for Key West, and was held before the wind on a southwest course and crost the path of the storm ahead of the center. The shift of the wind encountered was from northeast back to north and northwest, but there were no cross seas until after the center had past. By the morning of the 8th the storm had completed its recurve to the northeastward. On the morning of that day Bermuda, and Lloyds, London, were cabled that a tropical disturbance was approaching Bermuda from the southwest. By the morning of the 9th the center had past west and north of Bermuda and the reading of the barometer at Hamilton was 29.18 inches. The storm was exceptionally severe in the trans-Atlantic steamer tracks on the 10th and 11th. The experience of the North German Lloyd steamship *Koenigin Luise* indicates the intensity of the storm in the region of the Grand Banks. This steamship encountered the hurricane Septemer 10 in latitude north 39°, longitude west 55°, and at 8 p. m. the barometer read 28.06 inches. The vessel was unable to resume full speed until 5 a. m. of the 11th, fourteen hours after the storm began. The subsequent course and character of this storm will doubtless be determined by vessel reports that are not now available.

THE ATLANTIC COAST STORM OF SEPTEMBER 17.

Unsettled weather conditions over the West Indies followed the passage of the storm of August 31–September 11 over the

Western Atlantic, and on the 12th there was evidence of a slight depression near Porto Rico. From this position it moved to the neighborhood of the Windward Channel by the 13th, where there were indications of its presence on the 14th, after which it appeared to pass northward over the ocean. During the 16th falling barometer and increasing northerly winds along the south Atlantic coast showed the presence of a barometric disturbance off that coast, but an absence of reports from the great ocean area rendered it impossible to locate the center of the disturbance or to determine its future course. On the morning of the 17th its close approach to the Carolina coast was shown, and by 1 p. m. it had reached the coast line north of Charleston, where the barometer at that hour read 29.44 inches and the wind had reached a velocity of 46 miles an hour from the west. At Wilmington the maximum velocity had been 52 miles an hour from the northeast. After crossing the coast line the storm lost strength rapidly, and during its subsequent course to the lower Ohio Valley and thence northeastward its energy was expended in heavy rains. Damage on land by wind was of a minor character, and no serious injury to property has been reported. The damage to shipping along the coast between Charleston and Wilmington was, however, considerable, and crops were destroyed near Georgetown where the storm moved inland. West Indian stations in the indicated line of its advance were notified on the 12th and 13th of the character of the slight barometric depression from which this storm sprang. During the succeeding two days its presence off our southern coasts was but faintly indicated by land observations. On the 15th advices were issued that there was evidence of a disturbance between the Carolina coast and Bermuda that was apparently moving northward. The storm that struck the South Carolina coast was a small tornado-like development in the southern end, or tail, of the disturbance referred to, and its origin and course was a product of oceanic atmospheric conditions that were not shown by land observations.

The observer of the Weather Bureau at Charleston, S. C., reports as follows regarding this storm:

On the day preceding the storm no unusual phenomena were observed at this station. The barometer began to fall at 11 p. m., of the 16th, and fell steadily until it reached a minimum of 29.44 inches at 1 p. m. of the 17th, after which it rose rapidly. Light to moderate northerly winds continued during the 16th, shifted to northwest at 5 a. m., 17th, and backed to south at 5 p. m., from which quarter it continued until midnight. From 11 a. m. to 9 p. m. it blew a moderate and at times a fresh gale, the highest velocity, 48 miles an hour, occurring at 3:30 p. m. By midnight it had diminished to 22 miles an hour.

The damage to buildings in Charleston was small, not exceeding $1000, and was confined principally to small buildings. At Georgetown, S. C., a small town 60 miles northeast from Charleston, the damage was estimated at $15,000. The winds being offshore during the storm, the storm tide did not exceed the normal high tide more than one and a half feet, and consequently no damage resulted from high water in exposed portions of the city.

THE CARIBBEAN SEA STORM OF SEPTEMBER 23–27, 1906.

This was the severest disturbance that has visited the Gulf coast since the occurrence, on September 8, 1900, of the storm that devastated Galveston. That storm advanced from the eastern Caribbean Sea to the Texas coast during September 1 to 8, 1900. The September, 1906, storm was first definitely located over the western portion of the Caribbean Sea on the 22d and crossed the Gulf coast line west of Mobile the morning of the 27th. After leaving the Yucatan Channel, on the 24th, the storm moved almost due northward over the Gulf of Mexico. During this period there was an almost equal chance for the center to swing to the northeastward over the Florida Peninsula and thence along the Atlantic coast, or to the northwestward to the Texas coast. Daily advices and warnings based upon careful calculations announced, however, that its course would probably be northward toward the central Gulf coast, and beginning on the 23d Gulf shipping was advised to remain in port. When a storm of this type is hundreds of miles from reporting coast stations it is apparent that its intensity and exact course can not be accurately determined. The warnings issued during the four days of its progress over the Gulf were based upon an assumption that the disturbance possest in full degree the intensity that usually characterizes storms that advance from the Caribbean Sea over the Gulf of Mexico; and day by day the statement was clearly made that conditions dangerous to shipping would exist over the central and east Gulf. So far as known the warnings were heeded, and vessels did not venture into the threatened district. It is a fact, indeed, that of the millions of dollars of damage an infinitesimal portion was done to shipping in the open Gulf. The monetary value of vessels and cargoes thus protected, and the number of human lives safeguarded, can not now be calculated. Adequate protection could not have been made against damage and destruction by banked up water from the Gulf that swept over harbors, bays, inlets, and low-lying coasts, and from washouts due to torrential rains that attend storms of this character. The center of the storm crost the coast line near and west of Mobile at about 8 a. m., seventy-fifth meridian time, of the 27th. East of the point where the center crost the coast an onshore southerly gale combined with the wave from the Gulf to drag vessels from their anchorage, and caused water damage to shore property that was not experienced west of the storm's path, where northerly offshore winds prevailed during the period of the storm's greatest intensity. After the 27th the strength of the storm diminished rapidly, and during its subsequent course northward over the lower and middle Mississippi Valley heavy rains fell within its area.

The following are accounts by observers of the Weather Bureau and newspapers of storm action and losses at and near their respective cities:

Tampa, Fla.

The Weather Bureau followed the disturbance from its inception to its destructive violence at Mobile and Pensacola, and many congratulations have been received on its good work in keeping so closely in touch with the progress and development of the storm. The first information regarding the storm was received at 11:45 a. m., September 23, when the disturbance was near Grand Cayman and moving toward the Yucatan Channel. At this station the approach and passage of the storm over the Gulf was shown by violent squalls of wind, rapidly moving clouds, and abnormally high tides.—*Jno. S. Hazen, Local Forecaster.*

The Tampa Tribune, of September 30, 1906, comments editorially on the storm as follows:

The great storm in the Gulf has given an excellent demonstration of the effectiveness, accuracy, and practical utility of the Government weather forecasts. It was on last Sunday that the Weather Bureau office in Tampa flew its warnings of the approach of a great tropical storm which was then appearing in the region of the Yucatan Channel. From that time on the Bureau sent daily and urgent warnings of the progress of the disturbance. As the storm came within the area of a more intimate observation, its character, severity, and direction were more closely reported. The second day before it struck the coast, special warnings were sent to Gulf ports for the guidance of shipping, with the most urgent advice that vessels remain in port till after the disturbance. It is already known that many vessels heeded this warning and were without doubt saved because of it. * * * That the storm would strike the middle Gulf coast with great fury was the notification given two days before it struck. That the city of Pensacola was in especially grave danger, and would be near the center of the most severe disturbance, was announced twenty-four hours before the storm broke over that city.

New Orleans, La.

The severest storm that has visited the middle Gulf coast for several years prevailed from September 25 to 27. The work of the Weather Bureau in forecasting the progress, probable path, and intensity of this storm was exact in almost every particular. The system of distribution of storm-warning advices is so complete that not only did places having telegraph and telephone service receive the warnings, but thru the intelligent and prompt action of all employees and agents of the Bureau every fishing camp received timely warning. Acting on advices people in exposed localities sought places of safety, and vessels either remained in port or sought shelter in protected places along the rivers and bayous.

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THE ATLANTIC COAST STORM OF SEPTEMBER 17.

Unsettled weather conditions over the West Indies followed the passage of the storm of August 31–September 11 over the

Every precaution was taken to reduce the damage from the approaching storm to a minimum. On the morning of the 27th there was about three feet of backwater in the river at New Orleans, indicating a storm tide at the mouth of the river of six feet or more. Such a high tide is exceedingly dangerous, and but for the timely precautions taken there would have doubtless been much loss of life and property. The highest wind velocity reached at New Orleans was 49 miles an hour from the northwest at 8 a. m. of the 27th, and the lowest barometer on record for the station during the summer months, 29.14 inches, was reached at 8:15 a. m. of the 27th (see fig. 1). The storm was severe east of New Orleans, but there does not appear to have been any loss of life on the Mississippi and Louisiana coasts. The damage to property that could not be moved or protected was great. At Burwood the tide was over the wharf, which is eight feet above mean Gulf level. Railroads and crops suffered great damage.

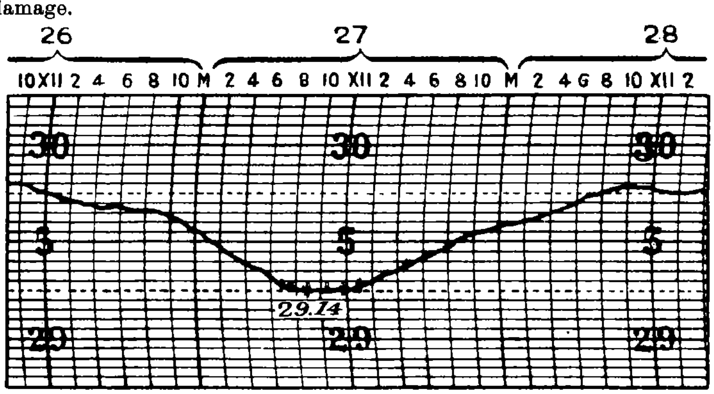

FIG. 1.—Barogram, New Orleans, La., September 26-28, 1906.

It is impossible to estimate the amount of damage that was caused by the storm in this section, but it amounts to several million dollars. Shipping remained in port and prepared for the storm, and there have been no great losses reported. The losses in this section were exceptionally small for such a storm, and this is attributed by the press and public to precautions taken on account of the timely warnings issued by the Weather Bureau, as indicated by the following extracts from editorials that appeared in the local press.

The Times-Democrat of September 28, 1906:

While only meager details of the damage wrought by the storm on the Gulf littoral are obtainable on account of injury to the telegraph service, the reports indicate severe losses of property at several points on the coast, much suffering and inconvenience in a number of communities, and possibly a loss of life. No doubt the losses would have been much greater but for the timely and accurate warning given by the United States Weather Bureau. Notice that the disturbance was approaching the coast, and that it was unusually severe in character, enabled shipping interests to avoid the dangers of the open sea, and very greatly minimized the damage incident to the violent visitation. Because of the high standard of efficiency reached by the Weather Bureau, and the extension of the service to West Indian points, we may now escape many disasters of the character hitherto experienced during these meteorological disturbances; indeed with reasonable care we should be able to reduce our losses on the coast, and in the Gulf, to the minimum.

The Daily Picayune of September 29, 1906:

When the full record of the damage from the recent storm will be made up it will be found that altho the property loss has been quite extensive the total loss of life has not been nearly so great as in many past storms of even less magnitude. This fact was probably due to the timely warning of the storm's approach, which enabled everybody likely to be especially exposed to take proper precautions.

Pensacola, Fla.

This was the most terrific storm in the history of Pensacola, or since the village of Pensacola, on Santa Rosa Island, was swept away 170 years ago. The greatest loss was to the shipping interests; a large number of ocean going vessels, tug boats, fishing smacks, launches, and craft of all kinds were wrecked upon the beach; the wreckage is strewn from Magnolia Bluff to the entrance of the harbor. During the early morning hours the people of the city were panic stricken, many believing that a repetition of the Galveston disaster was imminent, and large numbers of people took refuge in the higher portion of the city, braving the high-winds and stinging sand-filled rain in the hope of reaching a place of safety. When the wind reached 60 miles per hour (at 1:07 a. m.), every effort was made to protect property and life and people were driven from their homes along the water front. Trees were uprooted; houses were unroofed, and vessels in the harbor began to drag their anchors, being slowly but surely forced upon the beach. At the height of the storm (between 3 and 4 a. m.) the water rose $8\frac{1}{2}$ feet above the normal high-water mark, being the highest known. The great protection afforded by Santa Rosa Island saved Pensacola from more severe suffering. The entire water front property was inundated, the water reaching many houses; some were either carried away completely or irreparably damaged. Muscogee wharf was broken in two in the middle, and the tracks on either side of the main dock were washt away. Thirty-eight coal cars which were on the wharf were washt away. A timber boom was broken and the timber cast adrift; this timber and wreckage of every description is jammed upon the beach in a torn and twisted mass. The water backed up in the low ground north of Intendencia street, where several cottages were innundated, the water in places reaching a depth of 10 feet. About the greatest havoc was wrought along West Main street, the south side of which has been completely washt away. The houses along the bay shore from Barcelona street to Perdido are in ruins and all along the shore innumerable vessels are scattered. The damage to the fishing industry alone will probably aggregate half a million dollars and that to the tow boat industry will aggregate as much more. Several wharfs are completely gone. On Palafox street from the wharf north to Wright street there is hardly a building that has escaped damage, and in many instances the losses will be heavy, as the tin roofs were blown from many and the driving rain damaged stocks to a great extent. The train service in and out of the city is completely paralyzed. A train came in from the north this morning during the storm, arriving many hours late, the train men reporting that every few yards it was necessary to stop and remove trees and poles from the track. From Magnolia Bluff to Milton the track is gone and a portion of Escambia Bridge is washt away. A channel was washt thru Santa Rosa Island east of the Life Saving Station; the station itself is gone and the entire shore is a mass of ruins. Fort Barrancas is much damaged, Fort Pickens has suffered severely, and Fort McRae is completely razed, the ruins of the old fort standing alone on the shore. [Figs. 2, 3, and 4 show some effects of the storm, and fig. 5 reproduces the barograph trace at Pensacola.]

There were only two of the local steamers in operation on the morning of the 28th, namely, the U. S. S. *Poe*, of the Quartermasters Department, net tonnage 106, and the dredge *Caucus*, of the Engineer Department, net tonnage about 1000; these vessels, together with the *Pilot*, belonging to the Pilot Association, net tonnage 66, and a few fishing smacks, took up anchorage behind High Bluff on the peninsula between Town Point and Deer Point, which sheltered them from the full force of the easterly gale, and they were protected from the Gulf by Santa Rosa Island. An idea of the force of the storm in that locality and westward from the navy-yard may be gained from the following facts. The *Pilot* and the *Caucus* were equipped with extra good ground tackle, but the *Poe* had only common large anchors. The *Pilot* let down one anchor at 1 a. m. in 16 feet of water with 75 fathoms of chain out, and another anchor with 45 fathoms of chain out at 2 a. m.; she took up anchors in 20 feet of water, having drifted about 150 yards; her engines were not working. The *Caucus* had two anchors out and half steam ahead, and with her bins half full of water, only drifted 100 yards. The *Poe* with full steam ahead dragged her two anchors three and one-half miles to the navy-yard where they caught in moorings used for coal barges, and this saved her from going ashore.

Wharfmaster Cox stated that the tide was fully ten feet above normal high tide along the city water front and twelve feet at Bayou Grande, based upon the reckonings of five reliable men. The sea swells entering the slip between Palafox and Baylen streets were from seven to twelve feet high between midnight and 7 a. m. and were about one hundred yards apart, lifting wharf timbers and boards as they rolled thru the slip and splashed over Cedar street. Oyster boats, launches, steam tugs, lighters, timbers and wreckage of all description are jammed together at the corner of Cedar and Baylen streets; the launch Wolverine, a boat 40 by 9 feet, past over Cedar street and entered the lot at the northeast corner of Baylen and Cedar streets, followed by other wreckage mentioned above. Trees fully exposed to the easterly gale in all parts of the city were blown down, the chinaberry and sycamores suffering most. All weak chimneys that were broadside to the east were tumbled to the westward. Whenever the wind got under a tin roof it rolled it off.

The foreign merchant vessels in port on the 26th were 5 steamships, 7 full-rigged ships, and 13 barks. One bark is a total wreck, and 11 other barks and ships are stranded; also an American schooner is sunk and over on her side. Before the hurricane there were in port 38 schooner-rigged fishing smacks; now 29 are ashore and 16 of these are probably total wrecks. Of 36 lumber barges only 8 remained afloat, and of 8 tugs 2 are afloat, 3 are totally wrecked and 3 can be floated.

The navy-yard was exposed to the full sweep of the easterly gale and all naval boats, except the *Isle De Luzon* and two water boats, are either sunk or ashore; this includes the wooden dry dock, and all coal barges except one; all tugs were sunk; the Spanish steel dry dock is apparently undamaged but aground; the entire water front at the yard is a mass of wreckage. Houses along the water front in Wolsey and Warrington are destroyed by either wind or water, and a great many are washt away.

The total known deaths are 32.

The estimated damage is as follows: to buildings in Pensacola by wind, \$50,000; to interior finishings and stock by rain, \$100,000; to buildings and wharfs, timber and lumber by tide from the sea, wind, and wave, \$775,000; to shipping, \$1,000,000; to telephone, telegraph,

FIG. 2.—The effect of the storm at Pensacola, Fla.; view looking northeastward along Baylen street, showing the jam of craft of every description, timber, and lumber.

electric light, and trolley wires, $20,000; to foliage of the city, including cost of clearing streets, $50,000; to railroads by tides from the sea and washouts by heavy rains, $125,000; total estimated damage in Pensacola, immediate anchorage, and water front as stated above, $2,120,000. In addition to the above we have an item that can hardly be estimated; that is, the washing away of lots along the water front caused by the water rushing out to seek its level in the Gulf after the storm had past from the water to the land surface; in many places there were embankments eight feet high where now there is a depth of water measuring five feet.

In the vicinity of Pensacola the damage is estimated to be: to navy-yard, forts, etc., $1,100,000; by tides along the shores of East Bay, Escambia Bay, etc., $125,000; by tides in St. Andrew Bay, "12 inches above anything in past nineteen years", $5000; by tides and wind at Apalachicola, Fla., $12,000; by winds and rain at Goulding, Fla., $13,000; to timber and turpentine interests in Escambia and Santa Rosa counties, $40,000.

The estimated damage by wind and wave, and height of tides at Pensacola during the severe storms of the past twenty-seven years, is as follows:

Date.	Damage.	Tide above normal.
		Feet.
October 2, 1893	$1,100	....
October 8, 1894	....	4.5
July 7, 1896	400,000	5.0
August 15, 1901	112,000	....
February 27, 1902	1,100	....
September 26–27, 1906	2,120,000	10.0

The following tidal heights from Pensacola eastward will give an idea of the wave that attended the storm of September 26–27, 1906: Pensacola Bay, 10 feet; East Bay, 9 feet; St. Andrew Bay, 6 feet; Apalachicola Bay, 5 feet.

During the past twenty-seven years there have been eighteen days on which the wind attained or exceeded a velocity of 50 miles an hour at Pensacola; of these the maximum velocities of 60 miles, or more, were the following: August 20, 1888, 60, sw.; October 2, 1893, 66, sw.; October 8, 1894, 68, ne.; July 7, 1896, 72, n.; August 15, 1901, 70, sw.; December 28, 1901, 60, sw.; September 27, 1906, 83, e.

The Pensacola Journal, September 30, 1906, remarked:

The efficiency of the service of the United States Weather Bureau in giving warning of approaching storms was never better demonstrated than during the recent hurricane, the first warning of which was received and sent out by the observer at Pensacola on September 22, four days before the gale became dangerous in this vicinity.

Mobile, Ala.

The storm of September 26–27 was more destructive than any other in the meteorological history of the station, involving a greater loss of property, more numerous marine disasters, and greater destruction to timber.

The storm approached this section without any optical premonitory signs or noticeable cloud formations. Cloudy weather with stratus clouds began on the morning of the 25th, and there was occasional sunshine until about noon of the 26th; and only light rain, at times a mere drizzle, was recorded during a part of this period. On the 26th the fall in

FIG. 3.—The effect of the storm at Pensacola, Fla.; view northward from Muscogee wharf, showing the effect of the high seas on the embankment.

FIG. 4.—The effect of the storm near Pensacola, Fla.; fishing smack driven ashore; damaged cement residence at Palmetto Beach; the waves broke in the second story windows and washt the foundations from under the veranda.

barometer pressure and the increase in wind velocity, which had been gradual, became more rapid toward night. The wind, which was remarkable for the severity and suddenness of its gusts, reached a maximum velocity of 25 miles an hour between 5 and 6 p. m. and higher velocities were attained during succeeding intervals until a maximum of 55 miles, from the east, for five minutes, was reached at 7:15 a. m. of the 27th, and a single mile was made in somewhat less than a minute; after which lower velocities were recorded and no high velocities occurred after 11 a. m. The direction of the wind varied from north to northeast till midnight of the 26–27th, then it was northeast till 6 a. m., then east prevailed with momentary gusts from the northeast and southeast till 8:05 a. m., and southeast afterwards with occasional gusts from the east.

The lowest reading of the barometer, 28.84 inches, was reached at 6:30 a. m. [See fig. 6.]

The rain, which was continuous from 12:05 p. m. of the 26th, at times became a heavy downpour. The amount which fell from 12:05 p. m. of the 26th to 7:20 p. m. of the 27th was 6.40 inches.

During the morning of the 26th, the tide reached within six inches of the top of the wharf; it then receded and was one or two feet below the level of the wharf till about 6 a. m. of the 27th; a rise then began and in about half an hour the water was near the top of the wharf; by 7:45 a. m. it had come into the third street from the river, and at 10 a. m. it attained its maximum stage, exceeding by about a foot the stage reached during the hurricane of 1893. During that memorable storm the water was about six feet above the wharf. In the hurricane of 1901 the tide did not reach so high a stage as in 1893. Markings at the Cotton Exchange Building indicate 13 inches higher water in 1906 then in 1893, and these differ but slightly from the average of measurements taken by Mr. Wright Smith. Mr. Smith's figures for the high water occasioned by the last three storms are as follows: 1893, 8.80 feet above mean tide; 1901, 8.25 feet; 1906, 9.87 feet.

The following is a list of storms with wind velocities of over fifty miles an hour which have occurred at Mobile since 1872:

August 20, 1888.—Maximum wind velocity 56 miles from the southeast; water 3 feet deep over wharfs; estimated damage, $10,000.

April 14, 1889.—Maximum wind velocity 60 miles from the southeast; estimated damage, $25,000.

October 2, 1893.—Maximum wind velocity 72 miles from the southeast; several vessels ashore; wholesale business district inundated, and stage of water said to be higher than at any time since 1852; seven lives lost in Mobile County; estimated damage by tides, $100,000; by winds, $50,000; storm more destructive on the Mississippi and Louisiana coasts.

August 15, 1901.—Maximum wind velocity 60 miles from the southeast; a number of small vessels lost; wholesale business section inundated; no loss of life; estimated damage by tide, $75,000; by winds, $25,000.

September 26–27, 1906.—About twenty buildings, mostly houses in the residential section of Mobile, demolished. Nearly all buildings were more or less damaged. Windows were blown in, chimneys felled, tin roofs rolled up, slates and shingles ript off so that few interiors of houses escaped damage by the rain. In some places heavy timbers were carried considerable distances. Many merchants in the wholesale district had elevated their wares, but the tide exceeded all previous stages and damaged the lowermost goods. All electric services were totally crippled, the telegraph wires being down by 3 a. m. of the 27th. The roads were made impassable by prostrated trees. There was only one life lost in Mobile. The wharfs were greatly damaged and shipping suffered considerably. The official list of American vessels wrecked, kept at the office of the collector of customs, is not yet completed. Unofficial records of all marine disasters show that in Mobile Bay and River there were 11 steamships, 17 barks and schooners, and 4 steamboats ashore or sunk, 12 tugboats sunk, ashore, or capsized, and numerous barges and smaller craft which met a similar fate. There are also 11 steamships, barks, and many smaller vessels dismantled or otherwise damaged. In Mobile the estimated damage to buildings and electric services by the wind is $500,000 and by the tide, $50,000. The damage to merchandise by the tide is $175,000, and by the rain and wind, $250,000. The damage to vessels owned in Mobile is $175,000. The damage to railroads entering Mobile is estimated at $500,000.

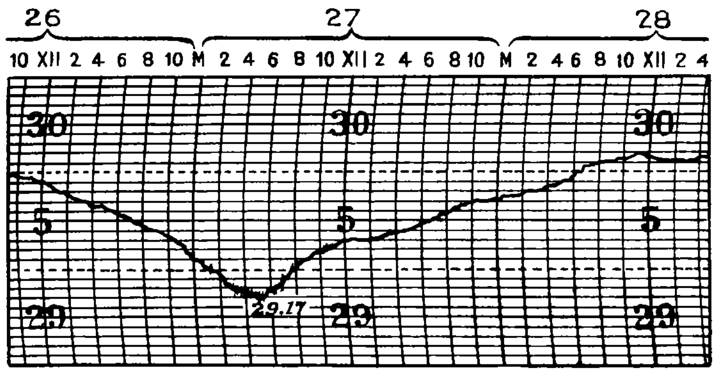

FIG. 5.—Barogram, Pensacola, Fla., September 26-28, 1906.

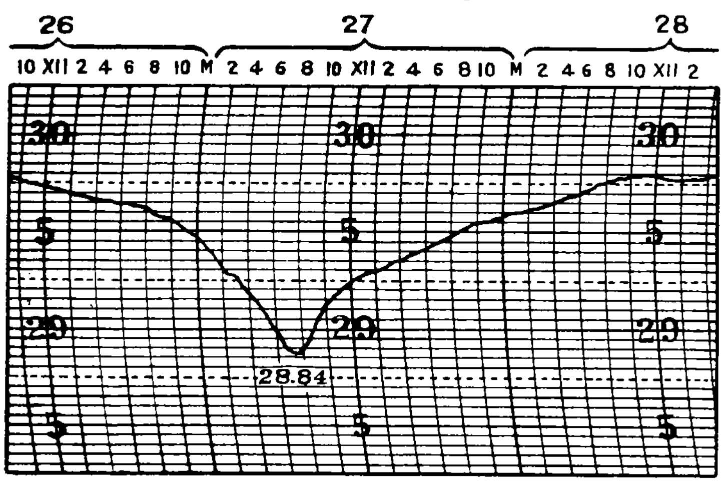

FIG. 6.—Barogram, Mobile, Ala., September 26-28, 1906.

The warnings of the Bureau prevented a greater loss of life, as nearly all vessels remained in the river. However, the storm was of so great severity that ships were torn from their moorings, collisions occurred, and the wind alone dismantled or damaged others. Till about 3 a. m. of the 27th, the office telephone was in almost continuous use; and as the barometer pressure continued to decrease, the information was given that the severity of the storm would increase. Shortly before 1 a. m., when the barometer pressure began to fall rapidly, the additional information was given that high tides were probable altho the northeast wind had prevented high water. The impracticability of securing labor during the already stormy conditions, the belief of many that only southeast winds can cause high tide, the absence of light in the early morning hours, and the subsequent rapid rise of the tide to a stage exceeding past records, greatly increased the amount of damage by water.

All localities in southern Alabama and southeastern Mississippi sustained great damage to property, but in the southern parts of Mobile and Baldwin counties the storm was most destructive to life and property and the damage will probably reach a million dollars. On the southern coast of Mobile County about one hundred persons lost their lives, mostly by drowning in the high tide which swept the coast.

Within a radius of 70 miles from Mobile about one half of all the timber boxed for turpentine production and from 5 to 35 per cent of all other timber has been blown down. It is not yet known how much may be utilized, and it is impracticable to approximate the loss as it is variously estimated from ten million to one hundred million dollars.

At Fort Morgan an anemometer, which owing to its worn condition registers velocities 5 per cent too low, was in temporary use during the storm. During the eight hours and forty-eight minutes ending at 2:45 a. m., at which time the aluminum anemometer cups were whirled off the steel arms, it recorded 590 miles. Several times after midnight a maximum velocity of 85 miles was recorded for a period of five minutes; 3 miles were recorded in two minutes, which is at the rate of 90 miles an hour; this, with a 5 per cent correction added, is more than 94 miles an hour.

Lieut. B. L. Brockway, of the U. S. Revenue steamer *Winona*, which was at Scranton, Miss., during the storm, sends the following memoranda, thru the observer at Mobile:

Date.	Hour.	Barometer reading.
		Inches.
September 25–26	midnight.	29.82
September 26	8:00 a. m.	29.80
Do	noon.	29.77
Do	8:00 p. m.	29.64
September 26–27	midnight.	29.45
September 27	4:00 a. m.	29.07
Do	4:30 a. m.	29.02
Do	5:00 a. m.	28.96
Do	5:10 a. m.	28.90
Do	5:30 a. m.	28.75
Do	6:00 a. m.	28.68
Do	6:30 a. m.	28.60
Do	6:45 a. m.	28.55
Do	7:00 a. m.	28.50
Do	7:45 a. m.	28.50
Do	noon.	28.70
September 27–28	midnight.	29.00

From the beginning of the blow till 7 a. m. the wind was north-northeast. The tide ran flood (opposite to the direction of the wind) until 7 a. m., when the barometer was at its lowest. For about fifteen minutes after 7 a. m. there was a lull in the wind; then it shifted to the south-southwest and blew with terrific force. The barometer began to rise, and the tide ran ebb with the same force it had run flood, the tide again running in the direction opposite to the wind.

The facts, to my mind, fully prove the theory that the low barometer made the high tide, and that the wind did not force the tide in, as is the usual belief. In each case the wind was blowing with terrific force in the opposite direction to that in which the tide was running. Furthermore the tide ran flood as long as the barometer dropt and when the barometer began to rise the tide began to run ebb.

Do you think that the low barometer and the lull in the storm indicate that we were in the center of the storm at Scranton?

The destructive tides that attend storms on our Atlantic and Gulf coasts are due in part to what are known as storm waves that are projected from the vortexes of atmospheric disturbances in which barometric gradients are very steep, and depend partly upon the force and duration of the wind from certain points of the compass. In the case of the storm of September 17 on the South Carolina coast, the duration of the onshore winds was too brief to cause a dangerous tide before the wind shifted to westerly. In the storm of September 26–27 on the middle Gulf coast, places on and near the coast west of the point where the vortex of the storm crost the coast line experienced only northerly, or offshore, gales; and the storm wave alone, as of the South Carolina storm, was not in itself especially destructive. To the eastward of the path of the storm, however, low-lying coastal tracts were subjected to the storm wave plus the waves driven in from the Gulf by a southerly, or onshore gale.

In the MONTHLY WEATHER REVIEW for May, 1896,[2] Gen. E. P. Alexander, of Georgetown, S. C., gives results of a study of the destructive forces on land of tropical storms that reach the Gulf and Atlantic coasts during the hurricane season, and suggests means of protection against the winds and waves that sometimes attend these storms. The following are extracts from the article referred to:

The maximum velocity of the hurricane wind has been known to

[2] Vol. XXIV, pp. 153-6.

exceed the rate of 120 miles an hour, but this is only in puffs of a few seconds' duration, as the total movement of the wind for a whole hour rarely exceeds 60 miles. Now, wind pressure is usually estimated at 2 pounds per square foot of surface when blowing perpendicular to that surface with a velocity of 20 miles per hour, 8 pounds for 40 miles, and 18 pounds for 60 miles, the pressure increasing as the square of velocity. [It will be observed that during the Gulf storm of September 26-27, 1906, the wind maintained a velocity of 70 miles at Pensacola for a whole hour.] If we assume the highest velocities and calculate the pressures by this rule, we should expect few ordinary houses to resist them. But in the wake of a storm, a study of the structures which fail and of those which resist is generally calculated to surprise an observer far more by the apparently weak ones which have resisted the winds than by the apparently substantial ones which have failed. And when those which have failed are examined, it will be found, almost invariably, that failures are due to unstable foundations or to lightly attached roofs. In fact, it may be taken as a measure of the force of hurricane winds that the frame of any ordinary house will resist them. But the foundations must be firm and the roofs fairly well framed and attached. In new houses, by the use of wooden ceilings instead of plastering, and a few angle irons and bolts, one can easily have a structure like a double box, which could be almost rolled over without injury. Old houses, badly constructed and with poor foundations, may be easily preserved by a few stout braces or inclined props on sides opposite the wind. In short the wind of a cyclone by itself seldom works serious injury. It is only where it has the water as an ally and accumulator of its forces that its ravages are great. When a hurricane passes inland it soon becomes little more than a bit of very bad weather. Its great instrument of destruction is the so-called tidal wave or storm tide, or, more properly, storm wave, which is raised by it and which submerges the low land of the coast. Below the limit to which these waves rise is the zone of danger in a hurricane; above it is the zone of easily attained safety.

How far this danger line may extend above ordinary high water depends so largely upon local configuration of coasts that it is only to be determined for any locality by observation. Unfortunately reliable measurements and data upon this point are rare and difficult to obtain. Popular accounts are always exaggerated, being largely based upon the action of surface billows, which send water and drift far above the general level of the storm wave. A vessel, for instance, drawing eight feet may be carried by successive billows across a marsh submerged only four feet beneath the general level. I have read accounts of combined storm waves and high tides rising ten or twelve feet above ordinary high-water mark, but when the action of billows is eliminated and careful measurements are made, the highest record of a storm tide above ordinary high water which I have been able to find anywhere is 8.2 feet. This limit was reached at Fort Pulaski, Ga., in the great gale of August 27, 1893, which broke all records in the height of its waters, in the destruction of life and property, and in the measured velocity of its wind, which at Charleston, for a few moments, exceeded 120 miles an hour. As this gale is one of great interest, the reader is referred to the records published in the MONTHLY WEATHER REVIEW for October, 1893, page 297.

The following table shows the rise of the tide caused by this hurricane, and for comparison, also, the highest storm tides ever recorded at several Gulf, Atlantic, and Lake ports, as shown by records of the U. S. Coast Survey and Engineer offices.

Highest storm tides at various points.

Locality.	Date.	Height of tide.	Moon's age.
		Feet.	*Days.*
Boston, Mass.	April 16, 1851	5.3	15
Sandy Hook, N. J.	September 10, 1889	3.9	14
Fort Monroe, Va.	March 10, 1846	5.1	12
South Island, S. C.	October 13, 1893	6.8	2
Fort Sumter, S. C.	August 27, 1893	6.4	14
Fort Pulaski, Ga.	August 27, 1893	8.2	14
Mobile, Ala.[3]	October 2, 1893	7.0	20
Buffalo, N. Y.	January 9, 1889	8.0	6
Duluth, Minn.	September 28, 1895	4.0	9

The plane of reference is ordinary high water, and the age of the moon is given in each case to indicate whether the storm tide coincided with the normal high tides, which occur at all Atlantic ports about each full or new moon. There is no tide at Lake ports, and but little in the Gulf.

From the above we see that the serious ravages are committed by the water rather than by the wind, and that they are confined to a narrow zone seldom, if ever, reaching more than eight or nine feet above the plane of ordinary high water. Above that zone ordinarily well built houses will easily resist the winds if the house and the roof are securely framed together and the foundations are stable. If there are weak points, even cheap and ordinary props or braces which can be improvised rapidly, are very effective in breaking up vibrations and resisting the pushes and shakes of the wind. Within the zone of danger from water, the dash of the waves and the tendency of the water to lift and float all wooden structures must be provided for. The limits of this article do not permit a full discussion of the magnitudes of these dangers and the various means by which they may be met, but it may be said briefly that pile foundations, or the equivalent, posts framed into buried timbers, are at once cheap and efficient.

[3] The tide of September 27, 1906, at Mobile, is reported to have been about one foot higher than that of 1893.—*E. B. G.*

WEIGHT OF SLEET ON SUSPENDED WIRES, CABLES, AND BRIDGES.

The breakage of telegraph lines and cables by the weight of the accumulated sleet, ice, and snow led us some years ago to ask that observers send to the MONTHLY WEATHER REVIEW some observations on the weight of sleet actually observed in ordinary and extreme cases. We now renew the request. Please state the size of wire, or cable, and the weight of ice per linear foot.—*C. A.*

RAINY OR SNOWY WEATHER AS FORETOLD BY HALOS.

It is a well-known fact that rain, snow, and general storms are frequently preceded by the appearance of halos, and especially simple circles around the sun or moon. The relation between these phenomena has been carefully studied in Europe, but I know of nothing especially bearing on this subject in America. Would not many of our observers, both regular and voluntary, do well to look over their past records, and tabulate the dates and hours on which halos were observed, more especially the 22-degree and 45-degree circles around the moon and the sun, with a statement of the weather that followed twenty-four hours later? Doubtless the halo will be a much better guide in predicting the weather in some places than in others.—*C. A.*

MONTHLY REVIEW OF THE PROGRESS OF CLIMATOLOGY THRUOUT THE WORLD.

By C. FITZHUGH TALMAN, U. S. Weather Bureau.

PUBLICATION OF CLIMATOLOGICAL RETURNS FOR THE BRITISH COLONIES.

It appears from a recent report of the British Meteorological Committee[1] that a proposition to provide for the publication, in convenient and accessible form, of the abundant climatological data now accumulating in nearly all the British colonies was recently considered by the Committee, and rejected on the score of expense. Following are extracts from a correspondence on this subject that past between the Colonial Office and the Treasury, which latter now has control of the Meteorological Office thru the newly constituted Meteorological Committee:

Letter from the Colonial Office to the Treasury.

DOWNING STREET,
5th August, 1905.

SIR: I am directed by Mr. Secretary Lyttelton to request you to inform the Lords Commissioners of the Treasury that as the result of an enquiry from the United States Weather Bureau for meteorological information with regard to Weihaiwei, he has had his attention drawn to the absence of any organization for the collection and publication of meteorological returns from the colonies generally, and for affording information to persons making enquiries as to climatic conditions in various parts of the British Empire.

It would appear that to a great extent in response to a circular of the 27th of July, 1895, the Meteorological Office receive a considerable amount of information, as shown in the enclosed print, which could with a little trouble be largely increased. Owing, however, to the want of the necessary clerical assistance most of these valuable returns serve

[1] Great Britain. Meteorological Office. First Report of the Meteorological Committee to the Lords Commissioners of His Majesty's Treasury, for the year ended 31st March, 1906. London, 1906.